DRF 3/14

Mean Life of the $2p^2\ {}^1D_2$ Level in O V†

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The suggestion [1] that an energetic ion beam passed through a thin foil could be used as a light source for the measurement of the mean lives of excited electronic states has been exploited by several workers [2,3,4,5]. References [2] and [4] applied this technique to cases in which the emitters were multiply charged and the radiations lay in the extreme ultraviolet. We report another such measurement.

A beam of O_2^+ ions, accelerated with a Van de Graaff accelerator to an energy of 1.44 MeV, was magnetically selected and passed through a carbon foil the thickness of which was 8 ± 3 $\mu gm/cm^2$. The pressure in the target chamber was 2×10^{-6} torr. The molecular ion was dissociated in the foil into monatomic ions which lost 40 ± 15 keV [6] in the foil. The emergent particles were observed, at 90° to the particle beam, with a McPherson 50 cm. vacuum Seya-Namioka monochromator with a 600 line/mm grating. The detector was a sodium salicylate coated EMI photomultiplier surrounded by a closely-fitting brass cylinder which was cooled with liquid nitrogen. The photomultiplier output was recorded with a current integrator. Another current integrator was connected to a plate which collected the particle beam. The particle beam currents were ~ 0.3 μamp.

We surveyed [7] the radiations in the wavelength region between 700 and 1500Å. With an instrumental line width of ~ 16Å, a number of lines

†Partly supported by NASA Grant NsG-628

were clearly resolved; these included λ 1339-43Å (from O IV) [8] and λ 1371Å (from O V) [8]. The intercombination line at λ 1356,59Å (from O I) was not seen. Kelly [8] lists the intensity of this line as small. The parent level can be expected to have a relatively long mean life since it can decay only by forbidden transitions.

The monochromator was set at λ 1371Å, the line arising from the transition $2p\ ^1P_1^o - 2p^2\ ^1D_2$ in O V. Photomultiplier counts were recorded for various positions of the foil relative to the entrance aperture of the monochromator. Such data, normalized to the number of incident beam particles, are directly applicable [1,2,3,4,5] to the determination of the mean life of the decaying level. Our data, corrected for dark current, are presented in Fig. 1. The straight line is a least squares fit and results in a measured mean life of $1.36 \pm 0.01 \times 10^{-9}$ sec. The uncertainty stems largely from uncertainty in the foil thickness and a consequent uncertainty in the particle velocity.

In passing, we note that Ref. 4 describes similar measurements on the lowest lying doublets in C IV, N V, O VI, F VII, and Ne VIII. A 32Å band pass was used. As Table 1 shows, the spectra of C I, N I, and O I include lines which, with that band pass, could not be resolved from the C IV, N V, and O VI lines to which Ref. 4 was devoted. Hence the wavelength measurement alone is insufficient to guarantee the absence of contributions from two different transitions. In our scans [7], lines due to O I, O IV, O V, and O VI were distinctly present. While the experiment of Ref. 4 was conducted at much higher particle energies (0.97 MeV/nucleon) than we have used, it is known [9] that deuterons with energies of 12.9 and 21.0 MeV can pick up neutralizing electrons on passing through gases. Hence it is

conceivable that excited neutral emitters of C, N, and O also emerged from the aluminum foils employed in Ref. 4, and a re-examination of this possibility appears warranted.

Table 1. Comparison of spectral lines studied in Ref. 4 and nearby lines listed in Ref. 8. Parenthetic numbers following the wavelengths are intensities given in Ref. 8. Wavelengths are in Ångstrom units.

Lines Used in Ref. 4	Nearby Lines [8]
C IV 1548.2 (20), 1550.8 (19).	C I 1542.2 (2), 1560.3 (8), 1560.7 (15), 1561.3 (2), 1561.3 (5), 1561.4 (20), 1561.4 (20).
N V 1238.8 (8), 1242.8 (7).	N I 1223.2 (3), 1225.0 (15), 1225.4 (10), 1227.0 (3), 1228.4 (5), 1228.8 (10), 1243.2 (20), 1243.3 (15).
O VI 1031.9 (10), 1037.6 (5).	O I 1025.8 (9), 1027.4 (20), 1028.2 (8), 1039.2 (20), 1040.9 (15), 1048.2 (8).

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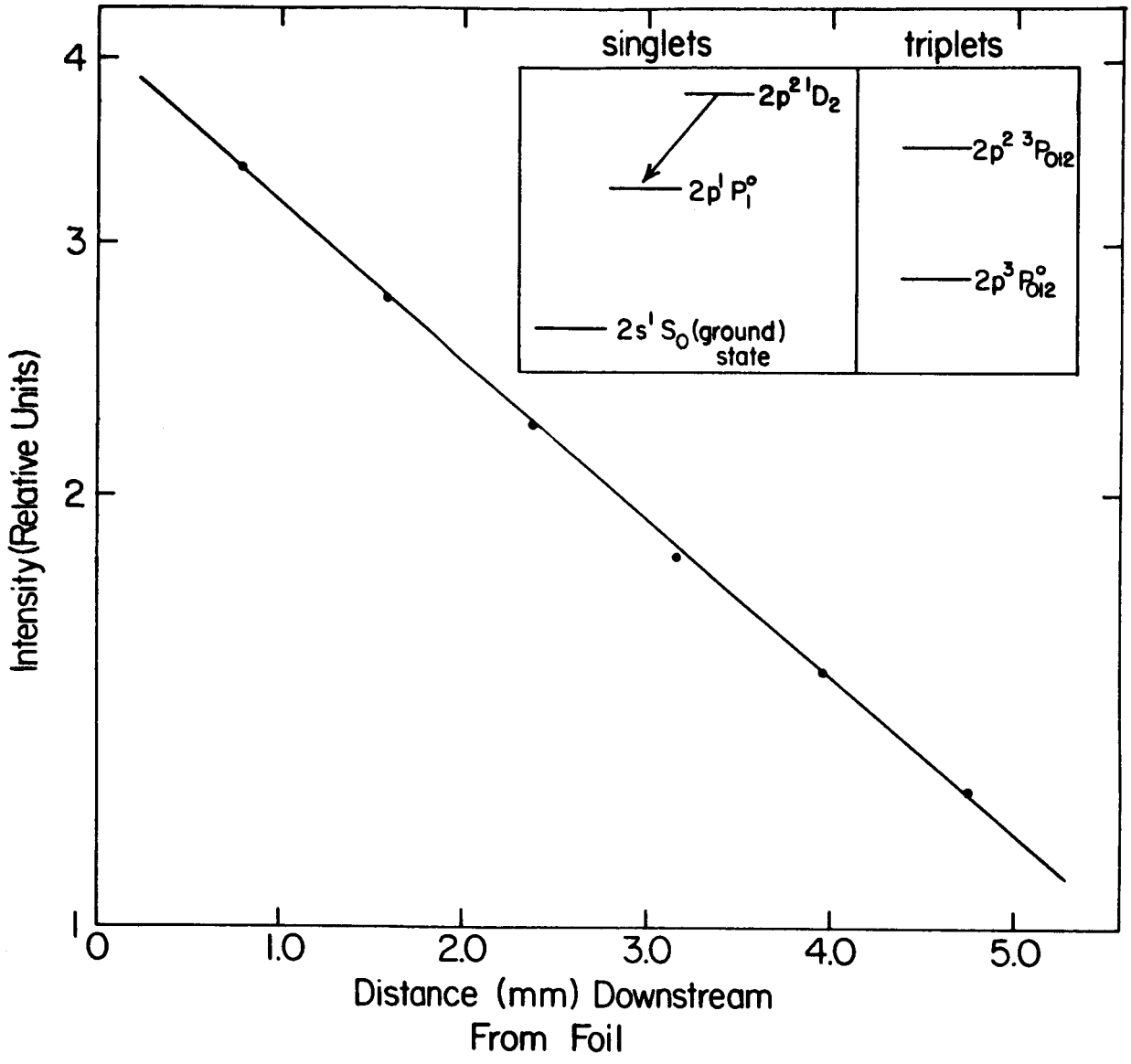
Figure Caption

Log intensity vs. distance for λ 1371Å line in O V. The insert shows the O V energy level diagram for the region of interest.


singlets
triplets
$2p^2\,{}^1D_2$
$2p^2\,{}^3P_{012}$
$2p\,{}^1P_1^o$
$2p^3\,{}^3P_{012}^o$
$2s^2\,{}^1S_0$ (ground) state
Intensity (Relative Units)
4
3
2
1
0
1.0
2.0
3.0
4.0
5.0
Distance (mm) Downstream From Foil